REMARKS/ARGUMENTS

In an Office Action mailed August 30, 2005 (the "Office Action"), the Examiner:

A. Rejected claims 22 and 24-26 under 35 U.S.C. 102(a) as being anticipated by Hasegawa et al. (U.S. Pat. 6,452,274);

B. Rejected claim 23 under 35 U.S.C. 103(a) as being unpatentable over Hasegawa et al. in view of Awano (U.S. Pat. Appplication Pub. 2002/0163079);

C. Rejected claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (U.S. Pat. Application Pub. 2002/0130407) in view of Cromwell (U.S. Pat. 5,926,370);

D. Rejected claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (U.S. Pat. Application Pub. 2002/0130407) in view of Montgomery et al. (U.S. Pat. Application Pub. 2003/011770);

The Applicant's attorney thanks the Examiner for the telephone interview held on February 8, 2006, in which the following remarks were discussed.

REMARKS

A. Rejection claims 22 and 24-26 under 35 U.S.C. 102(a) as being anticipated by Hasegawa et al. (U.S. Pat. 6,452,274)

Claims 22 and 24-26 have been canceled.

B. Rejection of claim 23 under 35 U.S.C. 103(a) as being unpatentable over Hasegawa et al. in view of Awano (U.S. Pat. Appplication Pub. 2002/0163079).

Claim 23 has been canceled.

C. Rejection of claim 28 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (U.S. Pat. Application Pub. 2002/0130407) in view of Cromwell (U.S. Pat. 5,926,370).

Cromwell discloses "a modular integrated apparatus that combines a CPU, a power converter, the associated power cables, and a printed circuit board into a system package that also functions as an EMI containment enclosure and a heat management device." (Cromwell, Field of the Invention) Note that the "heat management device" in Cromwell is not an integrated circuit die. Thus, Cromwell teaches nothing about how to make an integrated circuit die with enhanced power dissipation.

Dahl discloses "[n]ovel uses of diamondoid-containing materials in the field of microelectronics." (Dahl, abstract)

In Fig. 6B and the accompanying text, Dahl discloses "a diamondoid containing heat transfer film 620 is positioned adjacent to integrated circuit chip 601 and a heat sink 610. . . ." (Dahl, paragraph 0120) The heat sink may be made of copper. (Dahl, paragraph 0118)

In Fig. 6C and the accompanying text, Dahl discloses "heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package" (Dahl, paragraph 0121) The "heat conduits . . . of FIG. 6C may comprise any of the diamondoid-containing materials . . . ." (Dahl, paragraph 0122) The heat sink may be made of copper. (Dahl, paragraph 0118)

In the Office Action, the Examiner asserts:

> Cromwell teaches a heat dissipation/heat sink structure using conventional heat pipes (31 in Fig. 4b) where the heat pipes are made of conventional metal such as copper (Col. 10, line 22; Col. 9 and 10)
>
> It would have been obvious to a person of ordinary skill in the art at the time [the] invention was made to incorporate the HCM comprising copper as taught by Cromwell so that fabrication and processing can be simplified in Dahl et al's IC cooling structure. (emphasis added)

The Applicant respectfully disagrees with the Examiner's analysis, for the following reasons. Claim 28 requires that a heat conductive media comprising copper be contained within at least one cavity extending from the backside surface of an integrated circuit die substrate. Nothing in Dahl or Cromwell, either alone or in combination, discloses a heat conductive media comprising copper contained within at least one cavity extending from the backside surface of an integrated circuit die substrate.

Dahl discloses that heat conduits (e.g., 631 and 632) made of diamondoid-containing materials may be inserted into the chip. Copper is not a diamondoid-containing material.

In paragraph 0118, Dahl does disclose that heat sinks may be made of copper, but heat sinks (e.g., 610 in Fig. 6B and 630 in Fig. 6C) are separate and distinct from heat conduits (e.g., 631 and 632 in Fig. 6C). The only materials that Dahl discloses for the heat conduits are diamondoid-containing materials, not copper.

Cromwell does not disclose copper heat pipes contained in a cavity in an integrated circuit die. Rather, Cromwell discloses conventional, macroscopic heat pipes "made of copper" that "contain water that undergoes a phase change when the evaporating end of the heat pipes is heated. (Cromwell, Col. 10, lines 22-24) Such conventional heat pipes are too large to be incorporated in an integrated circuit die. Thus, contrary to the Examiner's stated motivation to combine Dahl with Cromwell, fabrication and processing would not be simplified by incorporating Cromwell's conventional heat pipes in Dahl et al's IC cooling structure.

Thus, Dahl and Cromwell, either alone or in combination, do not make claim 28 obvious because they do not disclose a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate.

In addition, as stated in *In re Kumar*: "to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention." (*In re Kumar*, 418 F.3d 1361, 1368 (Fed.Cir. 2005)). Here, even assuming for the sake of argument that Dahl and Cromwell disclose a heat conductive media comprising copper that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate (an incorrect assumption), Dahl and Cromwell fail to enable one of skill in the art to make such a structure.

As noted above, Cromwell is concerned with conventional heat pipes, so Cromwell teaches nothing about heat conduits in integrated circuit dies.

Dahl's discussion of heat conduits is contained in paragraph 0121, which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The heat conduits may be in fiber form, and may be inserted into

> the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in Dahl of: (1) how to make copper conduits in fiber form (either rigid or flexible); (2) how to insert from about 1 to 100 copper conduits into the chip; or (3) how to "communicate" with thermal vias (not shown). Thus, Dahl and Cromwell fail to enable one of skill in the art to make a heat conductive media comprising copper contained within at least one cavity extending from the backside surface of an integrated circuit substrate. Because Dahl and Cromwell fail to enable claim 28, Dahl and Cromwell also fail to make claim 28 obvious.

D. Rejection of claims 29-32 under 35 U.S.C. 103(a) as being unpatentable over Dahl et al. (U.S. Pat. Application Pub. 2002/0130407) in view of Montgomery et al. (U.S. Pat. Application Pub. 2003/011770).

Montgomery et al. disclose "carbon nanotube thermal interface structures." (Montgomery et al., Title) Note that the thermal interface structures make contact with the outer surface of an integrated circuit die, but are not located within an integrated circuit die. Thus, Montgomery et al. teach nothing about how to make structures within an integrated circuit die.

Dahl discloses "[n]ovel uses of diamondoid-containing materials in the field of microelectronics." (Dahl, abstract)

In Fig. 6C and the accompanying text, Dahl discloses "heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package" (Dahl, paragraph 0121) The "heat conduits . . . of FIG. 6C may comprise any of the diamondoid-containing materials . . . ." (Dahl, paragraph 0122)

In the Office Action, the Examiner asserts:

> Montgomery et al. teach a thermal interface structure (TIS)/heat dissipation structure wherein the HCM comprises heat conducting rods in [the] form of carbon nanotubes (see 26 in Fig. 4) to provide improved

thermal conductivity and heat dissipation between a die and a heat sink for the TIS (section 0017; pp. 1 and 2).

It would have been obvious to a person of ordinary skill in the art at the time [the] invention was made to incorporate the HCM comprising carbon nanotubes as taught by Montgomery et al. so that the thermal conduction and heat dissipation can be improved in Dahl et al's IC.

The Applicant respectfully disagrees with the Examiner's analysis, for the following reasons. Claim 29 requires that a heat conductive media comprising carbon nanotubes be contained within at least one cavity extending from the backside surface of an integrated circuit die substrate. Nothing in Dahl or Montgomery et al., either alone or in combination, discloses a heat conductive media comprising carbon nanotubes contained within at least one cavity extending from the backside surface of an integrated circuit die substrate.

Dahl discloses that heat conduits (e.g., 631 and 632) made of diamondoid-containing materials may be inserted into the chip. Carbon nanotubes are not a diamondoid-containing material.

Montgomery et al. do not disclose carbon nanotubes contained in a cavity in an integrated circuit die. Rather, Montgomery et al. disclose thermal interface structures that make contact with the outer surface of an integrated circuit die, but are not located within an integrated circuit die.

Thus, Dahl and Cromwell, either alone or in combination, do not make claim 28 obvious because they do not disclose heat conductive media comprising carbon nanotubes that are contained within at least one cavity extending from the backside surface of an integrated circuit substrate.

In addition, as stated in *In re Kumar*: "to render an invention unpatentable for obviousness, the prior art must enable a person of ordinary skill to make and use the invention." (*In re Kumar*, 418 F.3d 1361, 1368 (Fed.Cir. 2005)). Here, even assuming for the sake of argument that Dahl and Montgomery et al. disclose a heat conductive media comprising carbon nanotubes that is contained within at least one cavity extending from the backside surface of an integrated circuit substrate (an incorrect assumption), Dahl and Montgomery et al. fail to enable one of skill in the art to make such a structure.

Montgomery et al. teaches nothing about making structures within integrated circuit dies.

Dahl's discussion of heat conduits is contained in paragraph 0121, which states:

> In this embodiment, heat pipes or heat conduits 631, 632 may be used to conduct heat away from the chip to a heat sink located remotely from the package. The heat conduits may be in fiber form, and may be inserted into the integrated circuit chip itself at locations 633, 634, or they may communicate with thermal vias (not shown) within the chip. The heat conducting conduits may be flexible fibers, or rigid rods. There may be from about 1 to 100 of the heat conducting fibers or rods.

There is no teaching in Dahl of: (1) how to make carbon nanotube conduits in fiber form (either rigid or flexible); (2) how to insert from about 1 to 100 carbon nanotube conduits into the chip; or (3) how to "communicate" with thermal vias (not shown). Thus, Dahl and Montgomery et al. fail to enable one of skill in the art to make a heat conductive media comprising carbon nanotubes contained within at least one cavity extending from the backside surface of an integrated circuit substrate. Because Dahl and Montgomery et al. fail to enable claim 29, Dahl and Montgomery et al. also fail to make claim 29 obvious.

Because claim 29 is not made obvious by Dahl and Montgomery et al., dependent claims 30-32 are also not made obvious by Dahl and Montgomery et al.

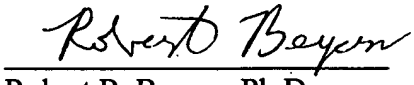
CONCLUSION

In light of the foregoing, the rejections in the Office Action mailed August 30, 2005 are believed to be traversed, and Applicant requests that the rejections be withdrawn and that the claims be passed to allowance.

If the Examiner believes a discussion of the above would be useful, he is invited to call the Applicant's attorney, Dr. Robert Beyers, at (650) 843-7528.

Respectfully submitted,

Date: February 8, 2006



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